

Eocene to Oligocene retrogression and recrystallization of the Stak eclogite in northwest Himalaya

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Abstract

Highly retrogressed eclogite is present in the Stak massif located on the northern edge of the Indian continental margin in northern Pakistan. Garnet in foliated samples contains omphacite inclusions ($X_{\text{jd}} = 0.33\text{-}0.40$) and quartz inclusions and latter retain Raman spectroscopic evidence for high residual pressures up to 0.52 GPa. These garnet grains do not show apparent compositional zoning. By contrast, one sample contains euhedral grains of garnet with quartz inclusions that show residual pressures as low as 0.25 GPa. These garnet grains do not contain omphacite inclusions, and show different compositional zoning compared to the omphacite-bearing garnet. The metamorphic condition of this sample was estimated to be 1.0-1.4 GPa/650-710 °C using residual pressure values of quartz inclusions in garnets and the garnet-clinopyroxene geothermometer. The U-Pb ages of zircon grains range from 158 to 28 Ma with a cluster between at ca. 32 Ma, which is younger than that of the peak ultrahigh-pressure metamorphic ages of eclogitic massifs in the northwestern Himalaya, e.g. Kaghan and Tso Morari. We suggest that the retrogressed eclogitic rocks in the Stak massif were heated by nearby Nanga Parbat Haramosh massif at ca. 32 Ma, subsequent to peak eclogite facies conditions. During this heating, part of the eclogite was largely recrystallized to form euhedral garnet grains. These results suggest that the Stak massif resided at a lower crustal depth while other ultrahigh-pressure massifs were exhumed in western Himalaya.